OPPORTUNITIES IN RESEARCH

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Talk by Dr. Byron T. Shaw, Administrator, Agricultural Research Service, U. S. Department of Agriculture, at 18th annual meeting of Hybrid Corn Industry Research Conference, Chicago, Illinois, December 13, 1963.

It is a great pleasure to join with good friends today in discussing the many opportunities that research offers for strengthening the corn industry and, in particular, the seed corn industry.

You are all familiar with the role of research in making possible the highly productive and successful hybrid corn that is grown on American farms today -- the development of the double cross at the Connecticut experiment station in 1917 . . . the subsequent nationwide effort by plant breeders to cross inbred lines to produce hybrids especially adapted to specific areas . . . the pooling of Federal and State resources in 1925 in an effort to speed up progress through exchange of breeding material . . . and, more recently, the fine work by industry, which has taken on more and more of the responsibilities of breeding hybrid corn.

This is all history. But if the research of the past has taught us how to breed hybrid corn and adapt it to our soils, climates, and various farming systems, then the research of today and tomorrow will expand and refine our knowledge so we can improve it even further -- in ways, perhaps, that we cannot even visualize.

The Russians understand and appreciate this. On a recent tour of the Soviet Union, I asked a Russian scientist why they didn't grow more grain sorghum instead of corn on some of their vast dry-land areas. I was told that Mr. Khrushchev likes corn, and furthermore, that he probably would even like to grow corn on the moon! Although Mr. Khrushchev may not be planning an immediate crop on the moon, he is certainly doing everything in his power to adapt hybrid corn to the soils and climate of his Russian homeland -- and with some success, I might add.

In our own country, problems of corn production have gone far beyond adaptation. For one thing, we are now concerned about protection against weeds, diseases, and insects -- against the newer and ever-changing forms of these pests that seem to show up as rapidly as we learn to control them. Right now, for example, growers are seriously threatened with corn stunt, a virus disease that is impossible to control with present knowledge. Fortunately, damage from this disease has not been widespread, although it has been heavy in individually infected fields. The danger lies in its potential for causing extensive destruction.

The Department is moving rapidly to launch a major cooperative attack on corn stunt, aimed at determining the insect that carries the virus from plant to plant, and locating a genetic source of resistance so breeders can develop lines that are not affected by the disease.

It is difficult to predict how fast we can move in this work -- it always seems too long to the growers whose fields are infested -- but we are moving as fast as our new knowledge will allow.

Control of corn stunt will certainly give growers a better chance to produce more efficiently -- and a little more security in their day-to-day struggle with the destructive forces of nature. Benefits will be passed on all along the line to those in fields allied to corn production. The seed industry will profit from incorporating additional useful and high-quality lines into their breeding stocks.

The Department is also moving against other diseases, the control of which will inevitably mean greater opportunities for better production.

One interesting and promising new lead was the recent discovery of a relationship between corn's resistance to stalk rot and corn borer, and the herbicides atrazine and simazine. Apparently, a naturally occurring chemical in corn imparts resistance to these herbicides as well as to various fungi, diseases, and insects.

Knowing the reaction of corn to these herbicides makes it easier for us to conduct detailed physiological studies of corn. And these studies may give us some of the information we need to help us determine the genetic nature of hybrid vigor and the inheritance of disease and insect resistance. Corn production is dependent upon these qualities, yet we have never found a satisfactory explanation for the phenomena.

We are learning more about the rusts, ear rot, helminthosporium, several varieties of borers, and downy mildew.

Let me give you a few brief examples of our work in this field:

A new inbred line resistant to all the commonly occurring races of the corn leaf rust was just developed in Iowa. A combination of early plantings and use of insecticides was shown to be effective in controlling the Southwestern corn borer, a very destructive pest of the South and one for which we have no resistant lines. The chromosome arms that carry the genes for resistance to the leaf-eating corn borer have been identified -- an important finding that may make it easier for us to develop resistant lines.

Weeds as well as diseases are a great problem and must be eliminated for greater efficiency of production. We are taking several directions in our work and have come up with some interesting findings.

Department and State scientists have found several synthetic compounds that can induce germination in witchweed. Use of these chemicals would enable us to germinate the parasitic plants all at once so they could be destroyed by any one of several methods.

We have found the natural stimulant in corn that can overcome the inhibitor in witchweed that keeps it from germinating. Concentrates of these stimulants have been purified and, theoretically, they could be used to control or even eradicate this dangerous parasitic plant.

Studies have shown that some of the newer triazine weed killers are not completely satisfactory because they leave residues affecting succeeding crops. Extensive research is now underway to develop other compounds that are equally effective but do not carry over into the next crop. We are also trying to find out how and why the herbicides act in the plant and why some leave residues while others do not. This kind of information is necessary if we are to develop the compounds that will act in precisely the manner we wish.

As you can see, our research effort to protect corn against the inroads of weeds, diseases, and insects is substantial, as indeed it must be if we are to stay at least one jump ahead of our problems in this field at all times.

In another totally different area of work, scientists are trying to improve planting and fertilizing operations and equipment in an effort to help corn producers increase efficiency. Much of our information on planting crops dates back to horse cultivation and we must step up our studies on these practices to keep up with the changes going on in every area of farming.

Studies showed that full-season chemical weed control can eliminate the need for cultivations beyond that at planting and fertilizing. In recent tests in Georgia, substantially higher yields were obtained with these minimum tillage techniques and chemical weed control than with conventional tillage.

In still another area, research engineers have devised a rapid and inexpensive process to determine the suitability of artificially dried corn for commercial uses, replacing time-consuming and expensive laboratory processes. The new technique involves measuring changes in the moisture content of the corn above the standard for corn of good quality. The higher the drying temperature, the less the moisture in the corn and the lower the quality.

Commercial users can utilize the method to select corn that will meet their individual requirements for wet milling and other end uses, as well as for safe storage. The new process represents a substantial contribution and its use can save the industry many thousands of dollars annually.

These, then, are a few of the approaches we are taking in our cooperative research on corn. The work is promising and much of it may be highly significant in returning greater benefits for producers and consumers and better opportunities for the industry in general.

In recent years, however, one important part of the work on hybrid corn-- the breeding and testing -- has been gradually taken on by a highly competent industry. This has left the Department free to tackle some of the deeper questions that can only be answered through basic investigations. As a result, a substantial share of our work today is devoted to this approach.

One of these newer areas of basic study is population genetics. We are attempting to find out how to manipulate corn populations to develop superior hybrids with a great range of qualities for breeders to choose from -- for industrial, feed, or food uses. We believe this will eventually lead to corn that is completely tailor-made for specific purposes.

We are applying the same techniques in studying plant pathogens so we will have some idea of how to predict their behavior. I mentioned earlier that these pathogens change as rapidly as we can develop new compounds to control them. The work that we are doing will give us a good idea of how they can change and how much -- <u>before</u> it happens.

Another important area of study is on mineral nutrition. Here, we have already done some fairly extensive work that has clearly established the need for various minerals for plant growth. But we need to know a great deal more about how these nutrients are absorbed from the soil and translocated and used by the plant. This will enable us to make far more effective use of fertilizers than is possible now in corn production -- or in production of any crop, for that matter. The savings could be substantial.

Another of the newer, highly important areas is that of biochemistry of corn. This encompasses a wide range of highly significant work, some of which you are familiar with because you have helped to bring it about.

We want to determine precisely how the plant synthesizes protein, oil, and carbohydrate. We start from the generally accepted belief that all biochemical reactions are controlled by enzymes. So we work with simple enzymes, introduce genetic control, and theoretically, we should learn, step by step, how the plant puts together some of its highly important components.

By understanding the nature of this process, we should be able to modify the enzymes through breeding in any direction and in any amount we wish, for practically any purpose -- for use in livestock feed, industry, or for human consumption.

And so we move ahead in our pioneering attempts to explore and discover concepts and ideas that will eventually provide the foundation for the agriculture of the future.

In any balanced agricultural research program, it is not enough merely to develop effective means of production without giving equal attention to developing adequate and growing markets to insure that farm products are utilized to the fullest extent possible. This is especially critical now that we have abundant quantities of corn and other cereal crops beyond those needed to satisfy current needs.

Both domestic consumption and export potential of these grains could be increased considerably by development of new products for use by industry or by improvement of foods and feeds. Our most practical approach in achieving these ends is through utilization research to find out all we can about the natural qualities of farm products -- and to make the fullest possible use of them by developing new and improved methods of processing.

Industrially, increased use of corn will depend largely upon increased markets for starch. The Department has made and is continuing to make gratifying progress in this direction with the development of starches that have unusual market potential.

One of these is amylose -- a starch with unique film- and fiber-forming properties. In cooperative work so far, the breeders have been able to develop varieties of corn containing starch that is 50 to 70 percent amylose. We are shooting for 80 percent, the level at which we feel the starch can compete more successfully as a raw material with ordinary starch. Even at the lower level, industry utilized over 4 million pounds from the first commercial plantings in 1961.

In one highly interesting study just completed, we discovered a moth that consistently feeds on corn with low amylose content, its feeding interests decreasing as amylose content goes up. So, unwittingly, the appetite of this particular moth may give us a useful screening test for use by plant breeders in selecting for high-amylose corn.

We estimate that success in the research on amylose could lead to consumption of over 600 million pounds of high-amylose starch by 1975 in films, fibers, coatings, and related products.

Dialdehyde starch is another useful product that is already being produced commercially, using an improved electrolytic process developed by the Department. Research has demonstrated the value of dialdehyde starch in tanning leather and as an agent for producing wet-strength paper.

The flour derived from corn is essentially a mixture of starch, protein, and minor components, and has promise as a raw material for conversion to adhesives, water-soluble coatings, plastic materials, and related products.

Isolated protein components of the flour should make suitable raw materials for production of useful resins and films. Zein, for example, a protein component of corn, has been chemically changed to produce a water-soluble product with a wide variety of industrial uses -- pharmaceuticals, cosmetics, floor polish, printing inks, leather finishes, and films and protective coatings.

Various fermentation procedures have been worked out to convert corn into new industrial, food, and feed products.

Some highly interesting work is underway on development of insect attractants . . . biological pesticides for the Japanese beetle . . . and plant antibiotics . . . all grown from grain-based cultures.

Investigations are also underway to provide basic information on the carotenoid pigments in corn so we can see how processing affects the potency of pro-vitamin A, important in food and feed uses . . . and the xanthophylls, important in broiler production.

Thus, by finding wider commercial and food markets . . . by developing new and improved products . . . by adding to farm income and establishing new rural industries . . . utilization research has contributed to producers, processors, and to the whole economy.

We feel that we have made progress in all our work to improve crop production.

There is still much that research must do to help growers produce efficiently, however. You may better appreciate the need for increasing efficiency when you realize than in less than 50 years, we may have around 424 million people in this country -- an increase of 125 per-cent. This means we will need more than twice as much food as we have now. Farmers will have to more than double their present output of crops and livestock on only a little more land and with considerably less manpower.

We can and we must meet these needs.

In meeting them, we will be facing both a stiff challenge and a great opportunity -- a challenge for research to provide the ideas and methods necessary to increase efficiency, and an opportunity for producers and processors to utilize these ideas and methods for the benefit of the American people.

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